Biogeosciences Discussions

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Reply on RC2 (Anonymous)

Frédérique M. S. A. Kirkels et al.

Author comment on "From soil to sea: sources and transport of organic carbon traced by tetraether lipids in the monsoonal Godavari River, India" by Frédérique M. S. A. Kirkels et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-116-AC2, 2022

Replies to reviewer #2

This study by Kirkels et al. investigates sources and transport processes of the presumed soil biomarker branched GDGTs in the Godavari river (India) and associated soils and sediments during wet and dry seasons. They provide ample evidence that additional riverine and marine sources hamper the use of brGDGTs for paleoreconstruction at this site. Their results are discussed in light of previous findings and differences to other monsoonal systems are highlighted. This is a well-written paper with a thorough and balanced discussion, which despite its length and number of complex figures does not feel lengthy.

Reply: We would like to thank this reviewer for their positive evaluation of our manuscript and appreciate that they did not experience the manuscript as lengthy despite the large and complex dataset that is being presented.

To make this paper a more attractive read, I suggest to change the title and headers of the discussion from "descriptions" to actual statements that reflect the main findings. For instance, the title currently does not really reflect the main finding that soil brGDGT signals are overprinted by riverine and marine in situ production.

Reply: Thank you for the suggestion. We will change the titles and headers of the discussion to match the content/main finding of each section.

Ln 67: We now know of several bacteria that synthesize brGDGTS (Halamka et al., 2021 doi: 10.7185/geochemlet.2132; Sinninghe Damsté et al., 2018). Therefore, I wouldn't doubt that bacteria are truly their source and consequently would use another word than enigmatic.

Reply: We agree with this comment. The enigmatic was more directed towards the exact bacteria that may produce brGDGTs. We will rephrase this sentence.

Ln 70-73: There is recent evidence that there are also bacteria that do not produce iso-diabolic acids that synthesize brGDGTs (Halamka et al., 2022 https://doi.org/10.31223/X5WD2C), therefore, I suggest to be more careful with the statements made here.

Reply: On hindsight, we decided to constrain our references to work that has passed the scientific peer-review procedure. We will revise this sentence to match the latest findings, but will refrain from referring to this work, as well as that of Chen et al., 2022 in the revised version.

Ln 75: Please also acknowledge the work of Halamaka et al. (2021) here.

Reply: A similar request was made by the other reviewer Dr Naafs. We will add this reference.

Ln220 onwards: Does this mean that these samples (dry season SPM, riverbed sediments, and fine fractions of soils) were not saponified, while wet season SPM and bulk soils were saponified? Why were these samples treated differently? Saponification may release also some IPL-GDGTs as core GDGTs and affect ratios, also of isoGDGTs to brGDGTs. Have the authors considered the effect of this? Also, there is no reference for the Al2O3 column separation, was this tested for the effectiveness (and yields) for core GDGTs?

Reply: A similar comment was made by the other reviewer. Indeed, only wet season SPM and soils were saponified to isolate fatty acids used in the study by Usman et al., 2018. There, the choice was made to only study material collected during the wet season when most soil mobilization and transport is taking place. Since the isolation of fatty acids requires additional steps in the workup procedure and we had a large number of samples (>300), we decided to optimize the workup procedure for our target compounds brGDGTs.

In addition, we believe that the potential contribution of IPL-derived brGDGTs to the measured brGDGT signal will be marginal due to the following reasons:
- Logistics in the field did not allow us to store our samples frozen after sampling and transport, facilitating *the degradation of IPLs on the road.*
- Our samples have been extracted with the ASE that uses high temperature and pressure, which degrades IPLs in the process.
- The %IPL-derived brGDGTs in soils is generally much lower than the pool of 'fossil' brGDGTs that are present as core lipids (e.g. Peterse et al., 2010; Huguet et al., 2010; Zell et al., 2013), which thus represent the majority (>80%) of the brGDGT signal. This is also true in river SPM (e.g., Zell et al., 2013; De Jonge et al., 2014). Given that IPL-derived brGDGTs and core lipid brGDGTs generally have a similar distribution in soils and river SPM, the work up procedure followed here is not considered to introduce large differences in brGDGT distributions nor concentrations the dataset.

The separation of total lipid extracts over a Al_2O_3 column to isolate a GDGT fraction is a common procedure followed by many labs globally and does not have an original citation.

Ln 239: Change to APCI

Reply: we will change this

I find many of the titles in the discussion bland. To keep the reader excited I suggest to instead mention the main finding in the title. For instance instead of "Spatial variations in GDGTs in Godavari soils" you could say "The effect of moisture and temperature on the spatial distribution of in GDGTs in Godavari soils" or instead of "Sources of GDGTs in the Godavari River" you could say "6-methyl-brGDGTs indicate in situ production in the Godavari River"

Reply: Thank you for this suggestion. We will definitely follow up on this in a revised manuscript.

Ln 539: replace "tears" with "teases"

Reply: We will change this.

Ln 550: Please indicate that you are now also referring to Fig. 6a and not only 6b.

Reply: We will add a reference to the appropriate figure(s) here.

Ln 573: Please also give credit here to the paper by Halamka et al., 2021 (doi: 10.7185/geochemlet.2132)

Reply: We will add this.

Ln576: How was it shown that the brGDGT producing bacteria were heterotrophic?

Reply: This was based on the d13C value of the hydrocarbons that were released from brGDGTs after ether cleavage in, for example soils that were exposed to labeled CO_2 (Weijers et al., 2010), or in soils along a transect away from a natural CO_2 vent with a distinct isotopic composition (Oppermann et al., 2010). These studies found that the d13C value of brGDGT-derived hydrocarbons matched that of CO_2 in a way that would fit with a heterotrophic lifestyle of their producers.

Ln 600: Did the authors see higher absolute amounts of crenarchaeol to confirm a higher activity of ammonia oxidizing archaea?

Reply: We are not entirely sure what the reviewer would like to know. The high(er) crenarchaeol concentrations in the dry season that is referred to here were reported in a study on the Lower Amazon by Zell et al. (2013). They found that seasonal variations in the BIT index were mostly driven by the production of crenarchaeol in the river. In the Godavari River, crenarchaeol concentrations are (somewhat) higher during the wet season that during the dry season. But more importantly, and in contrast to in the Lower Amazon, the in situ production of brGDGTs are more important in determining the BIT index here than crenarchaeol, as we state in line 602-604.

Fig. 7: Can you indicate in this plot again where the border of the Lower and Upper Godavari Basin is and where the North and East Tributary regions are? There is a red dashed line, I assume this is supposed to separate the two basins?

Reply: The red dashed line indeed separates the Upper and the Lower basin. We will better indicate the different subbasins in a revised figure.

5.3 and 5.4 onwards: Again, I recommend to choose more meaningful titles so the reader is informed on the most important points. Suggestions are "5.3.2 Low mineral associations during river transport" "5.3.3 The marine sedimentary brGDGT composition reflects the lower Godavari basin" or "5.3.4 Absence of size-related sorting in the Godavari River"

Reply: Again, thank you for the suggestion. We will follow up on this.

Ln 710: Do the authors have any idea why the depth profiles of the Godavari River look different to other monsoonal rivers?

Reply: The relatively little variation in the depth profiles from the Godavari River may possibly be explained by the lower flow velocity of the Godavari compared to that of other monsoonal rivers, especially those with a larger elevation gradient, such as the Amazon River and the Ganges-Brahmaputra Rivers that have a source >5000 m above sea level, whereas that of the Godavari River is at ~900 m. The lower flow velocity of the Godavari River likely causes coarser particles to sink rather than to be transported in the lower water mass as happens in the Amazon and Ganges-Brahmaputra Rivers.

Ln 741: Refer to correct figure here.

Reply: We will correct this.

References:

De Jonge et al., 2014, Geochimica et Comoschimica Acta 125, 475-491.

Huguet et al., 2010, Organic Geochemistry 41, 559-572

Oppermann et al., 2010, Geochimica et Cosmochimica Acta 74, 2697-2716

Peterse et al., 2010, Organic Geochemistry 41, 1171-1175

Weijers et al., 2010, Biogeosciences 7, 2959-2973

Zell et al., 2013, Limnology & Oceanography 58, 343-353